Aberrant hip geometry affects peak hip joint loading during normal walking

Lode Bosmans and Ilse Jonkers
KU Leuven, Department of Kinesiology, Human Movement Biomechanics, Belgium

Introduction: Previous research showed that gait deviations in children with cerebral palsy (CP), that present with aberrant hip geometry, like an increased neck-shaft angle (NSA) and increased femoral anteversion angle (FA), is associated with excessive hip joint loading [1]. In this study, we analyzed to what extent aberrant femoral bone geometry or gait kinematics affect the hip contact forces.

Material and methods: We used three different musculoskeletal models (MSM) of eight subjects (8-12yrs) with diplegic CP: (1) a rescaled generic MS model and (2) a rescaled deformable generic MSM, created by accommodating the FA, NSA and neck length of the generic model to the femoral geometry extracted from MR images and (3) a MRI-based subject-specific MS model. To calculate the hip contact forces during gait, normal gait kinematics and scaled kinetics of one typically developing child were imposed to all three models of the eight subjects during dynamic simulations of gait. The magnitude of the two peaks of the normalized resultant hip contact force was compared between the 3 model types and related to the degree of bony deformity.

Results: The first peak of the normalized resultant hip contact force differs between the three models (generic: 4.3±0.2, deform: 5.7±1.4, MRI: 5.1±1.0 times body weight). The second peak was comparable between the three model types. The magnitude of the first peak of the normalized hip contact force correlates to FA (deform: r=0.75, MRI: r=0.50) and NSA (deform: r=0.84, MRI: r=0.78).

Discussion: The inclusion of aberrant hip geometry and associated changes in hip muscle wrapping affects the magnitude of the calculated resultant hip contact force. More specific, independent of the specific gait deviations, the presence of femoral bone deformity will already overload the hip joint. Further research will focus on relating to what extent the subject-specific kinematics will compensate for this overloading.

References:

[1] Lenaerts et al., 2008. Subject-specific hip geometry affects predicted hip joint contact forces during gait. Journal of Biomechanics 41, 1243-1252.